ARIZONA TRANSPORTATION RESEARCH CENTER

RESEARCH NOTES:

Project 512

March 2005

ITS Traffic Data Consolidation System

The Arizona Department of Transportation (ADOT) maintains a variety of independent Intelligent Transportation Systems (ITS) applications to monitor and manage roadway conditions and events across the state, and to better inform travelers. The data includes traffic counts, weather, pavement conditions, signal timing, Variable Message Sign (VMS) text, camera images, and the statewide Highway Condition Reporting System (HCRS). Also, the public gets detailed travel information from ADOT's az511.com website, or from the 511 phone service.

Each ITS resource has its own unique user interface, security, output data format, and task initiation timetable, creating a need within ADOT for an effective Traffic Data Consolidation System. This report summarizes an ADOT research project to consolidate access on a single system for a variety of key data.

Phase One of this research provided access for HCRS users and website visitors to VMS sign messages, Closed Circuit Television (CCTV) roadway images, sensor data from Road Weather Information Systems (RWIS), and National Weather Service (NWS) forecasts and advisories. All of these functions are now integrated with the same application and user-friendly Graphical User Interface (GUI). Also, these data streams are being archived in the HCRS database.

Phase One was completed successfully ahead of schedule in August 2004, and project funds remained for a Phase Two. Based on field requests, other new HCRS enhancements were proposed by the project's Technical Advisory Committee (TAC). A new goal was defined to improve the user-friendliness of HCRS by allowing field users to enter highway mileposts graphically. This tool simplified field data entry, improved the location accuracy of road condition information, and automatically inferred the event's affected travel direction.

Ultimately, the resulting enhanced HCRS system has improved the real-time aspect of the operational management of the state highway system for ADOT, and the quality of Advanced Traveler Information Systems (ATIS) information for Arizona's highway users.

PROJECT CONCLUSIONS

Phase One integrated key data resources, making the data streams available for "big-picture" management of the state highway system. Phase Two improved the accuracy and speed of HCRS data entry with its graphical interface. Several key goals were achieved for highway operations:

- "Variable Message Sign" icons are located on the HCRS Map, with text available to both HCRS users and Internet browsers.

- Icons for CCTV still-images from RWIS stations and VMS structures appear as links on the HCRS and the az511.com website maps.

- Weather data from NWS and the ADOT RWIS system is gleaned from the Internet, linked to icons on the HCRS Map, and archived in the database.

- A Graphical User Interface was added to more easily locate HCRS events, using the map to provide milepost information.

- Numerous redundant display layers and icons were removed or simplified.

PROJECT LESSONS LEARNED

This complex integration project succeeded due to the management and oversight techniques employed by the TAC and OZ Engineering, the system integrator, and the lessons learned can benefit future projects. One issue was integration among third-party data providers and the system integrator, including "agreed upon" requirements for documentation. Due to the limited budget and schedule, not all data providers performed sufficient unit testing, and additional OZ research project resources had to be used in the integration and system test phases.

Third-party VMS and RWIS field contracts preceded the HCRS integration work by OZ, creating sporadic schedule conflicts or delays. Had all projects been scoped with eventual integration in mind, all vendors could have better coordinated and cooperated in their roles. Also, other HCRS and 511 functional development support work for ADOT highway operations necessarily took priority over the research tasks of this project.

The amount of data archived by the HCRS became an issue for this project's database. Initially, a storage capacity analysis should have been done for each data source, and procedures implemented prior to system integration. Also, ITS data archive stakeholders should have been consulted for the design. Still, the archived ITS information will be invaluable for transportation administration, policy evaluation, safety and performance monitoring, post-analysis engineering, and short- and long-term planning.

Significant troubleshooting was needed for the HCRS and RWIS/NWS interfaces. Problems between HCRS and the RWIS server and database slowed other unrelated HCRS functions. An end-to-end communications survey should have been done to insure each component is protected from unwarranted interaction with its peer components. A "spider" tool used to poll and collect data from NWS data web pages added to the problem. Software processes and server hardware are being reconfigured for better HCRS performance, to be operational by April 2005.

The Phase Two "Easy Entry" GUI upgrade made ADOT aware of a critical dependency on up-to-date milepost GIS shape files. ADOT is in the process of addressing this issue internally.

Finally, the TAC provided crucial insight and guidance to the project, but HCRS users (field site operators) could have been better represented. "Guest experts" might also have been consulted.

PROJECT RECOMMENDATIONS

The National Transportation Communications for ITS Protocol (NTCIP) is being developed jointly by the American Association of State Highway and Transportation Officials (AASHTO); the Institute of Transportation Engineers (ITE); and the National Electrical Manufacturers Association (NEMA), with funding by the Federal Highway Administration. It is recommended that these standards continue to be used as ITS integration projects are implemented.

Extensible Markup Language (XML) and XML Schema Definition (XSD) technologies flexibly define the "mutually agreed upon" syntax of data messages. This

project highly recommends that all software interface developers use XSD validators to test the XSD compliancy of their output locally, independent of parties on other side of an interface. For example, the NWS is currently working on producing its Forecasts and Advisories in XML format.

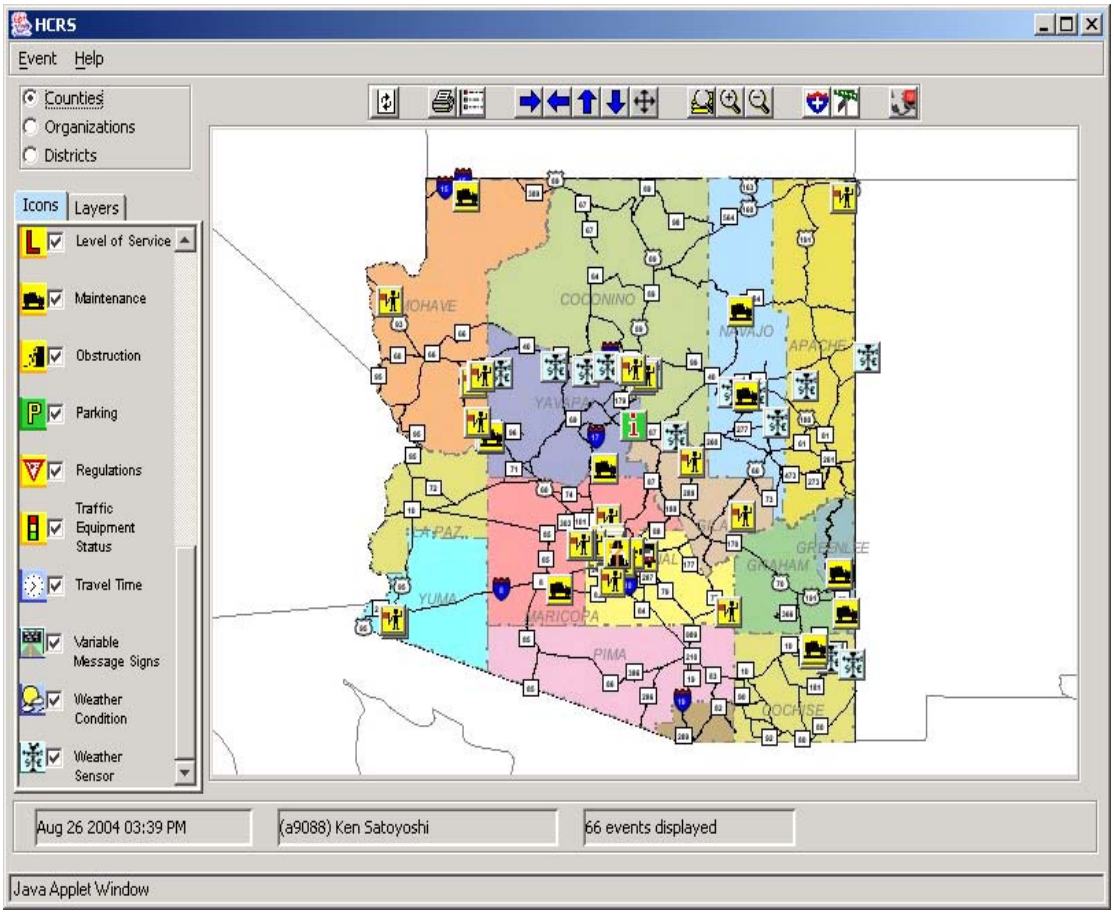
ADOT must improve its internal planning and information coordination so that HCRS data is ready when new freeway sections are opened. New procedures are required to provide updated GIS data as construction nears completion, update the 511 Interactive Voice Response system for any new roads, and perform an HCRS update for this data. The new freeway section should be available on az511.com and on 511 immediately, as of the official road opening.

The project recommends two other key areas for further expansion of statewide data:

- Traveler information: rural trip travel prediction; regional weather and road conditions.

- Roadway management information: more rural and urban CCTV still-images; GIS longitude, latitude and elevation as a mouse popup on the HCRS map.

It is strongly recommended that HCRS system enhancements continue to be made incrementally, for scheduling and budgetary reasons. The incremental approach may prolong the overall system integration timeline, but it will ensure successful completion of each project along the way.



Redesigned HCRS Client Screen

PROJECT BENEFITS

This research has created a single user-friendly application in HCRS for ADOT, with software interfaces to the key ITS programs in Phase One via the Internet and intranet. Phase Two has improved the accuracy and speed of HCRS data entry with a graphical user interface.

The project has resulted in more statewide centralization of key ITS data. ADOT highway managers at the state and district level now have an integrated operations tool that provides dynamic traffic and roadway data for distribution, display and decision-making.

The ADOT Highway Condition Reporting System is a statewide tool that provides integrated consistency of information both for roadway management, and for travelers across the state. This research project has effectively "raised the bar" for highway agencies with its collection and dissemination of advanced traveler information.

While this project was initiated by and for the ADOT field offices, Arizona's driving public now has access to much of the same real-time information via the Internet website and the 511 Interactive Voice Response system.

Also, recent findings by others on the perceptions of older drivers as to ADOT's use of ITS resources have been incorporated concurrently into the HCRS refinements. The results contribute greatly to enhanced public satisfaction with ADOT's traveler information by providing more and clearer reports, advisories, and camera images.

In the near future, the public may get information through new media such as Highway Advisory Radio, Personal Digital Assistants, and cell phones, as well as third-party value-added providers. Better and more timely advisories will reduce call-in overload, improve ADOT decision-making, enhance credibility, and reduce costs for travelers and for the transportation service sector.

This development project demonstrated how national standards, such as NTCIP, promote better interfacing and cooperation between government agencies and the commercial world, and consequently, faster product development.

Finally, by enabling better ITS data archiving, this project is an excellent resource for retrospective analysis by transportation planners to improve day-to-day real-time management of state highway systems.

The full report: *ITS Traffic Data Consolidation System* by Tomas Guerra and Ken Satoyoshi of OZ Engineering (Arizona Department of Transportation, report number FHWA-AZ-05-512, published March 2005) is available on the Internet. Educational and governmental agencies may order print copies from the Arizona Transportation Research Center, 206 S. 17 Ave., MD 075R, Phoenix, AZ 85007; FAX 602-712-3400. Businesses may order copies through ADOT's Engineering Records Section.